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Methodology

Economic Burden of Stroke in Iran: A Population-Based Study

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ABSTRACT

Objectives: This study was conducted to estimate the annual societal costs in Iran associated with the treatment of ischemic and hemorrhagic stroke patients using a prevalence-based cost-of-illness framework.

Methods: A prevalence-based cost-of-illness framework was applied. Key model parameters included annual incidence of stroke; use of stroke therapies, medicines, and other medical care resources; work days missed; wage rates; and annual costs per patient. The outcomes measured were total societal costs, societal cost per year, and societal cost per patient-year.

Results: For the studied 1940 patients, the economic burden of stroke in 2018 was roughly $4 081 124 in US dollars. Bearing in mind that there are about 100 000 cases of stroke, including new (35%) and old cases (65%) of 2 types of strokes, per year in Iran, the estimated economic impact is about $368 925 000. Lodging, medication, and consumables account for 69% of all direct medical costs ($299 959). The main cost factors were mortality costs (76.6%) and disability costs (14.7%).

Conclusion: The economic impact of stroke in Iran is considerable. The premature deaths and resulting disability from strokes accounted for the main productivity losses and all societal costs of stroke (approximately 91% of all costs). To control hypertension and decrease the burden of stroke, especially in elderly age groups, it is recommended that Iran look into how to focus on and expand healthy lifestyle choices.

Keywords: costs and cost analysis, cost of illness, disease management, Iran, stroke.

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Introduction

The "Global Burden of Disease, Injuries, and Risk Factors Report" in 2015 revealed that stroke is currently the second leading cause of deaths and long-term disabilities worldwide.[1] In the last decade, the incidence of strokes, survivors, and stroke-related deaths, in addition to disability-adjusted life-years, has increased globally. For example, ischemic stroke death has increased from 2 182 865 deaths in 1990 to 3 272 924 in 2013. Presently, 3% to 4% of total healthcare expenditures (HCE) in Western countries are spent on strokes.[2] Substantial decreases in stroke incidence, mortality, and disability-adjusted life-years have been achieved in high-income countries, but these success stories have not been mirrored in developing countries, where the incidence has risen sharply.[1,3] Recent studies have shown that the prevalence of stroke is significantly higher in Iran compared with Western countries, particularly hemorrhagic stroke and in younger populations.[4-6] Population-based studies are needed in stroke research and policy makers are interested in understanding the economic costs of illnesses for health resource allocation and to evaluate the potential benefits and costs of public health-related interventions.[7] The annual direct costs of stroke were estimated at €26.6 billion in 2010 for the European Union, Iceland, Norway, and Switzerland.[8] Based on primary searches, the economic burden caused by stroke has not been well explored in developing countries. Similarly, there is limited knowledge of the costs of the economic burden (both direct and indirect costs) of stroke in Iran. This article is an attempt to provide basic epidemiological and cost data on stroke, especially to estimate the cost of illness and economic burden of stroke in Iran in 2018 from a societal perspective.

Methods

The main approaches to estimating the burden of diseases are "prevalence-based" and "incidence-based" methods.[9] The prevalence-based method estimates the costs of an illness that occur concurrently with overall prevalent cases over a specified time period, usually over a year. On the other hand, an incidence-based method estimates the lifetime costs of an illness from the beginning of symptoms until the disease either resolves or results in death; it also incorporates a discount rate for the year when the disease was diagnosed.[10] In this study, a prevalence-based method was used to estimate the costs of illness imposed by ischemic and hemorrhagic stroke in Iran in 2018. This study was conducted

Table 1. The direct medical cost of strokes in Iran in 2018 (estimated in US dollars).

Procedures	Number of patients	Mean cost	Total cost	Total cost (percent)
Lodging	1940	$98	$190 408	44%
Medicine and consumables	1940	$56	$109 551	25%
Clinical visits	1940	$19	$37 076	9%
Other clinical costs	1940	$15	$28 773	6%
Laboratory visits	1864	$14	$25 914	6%
CT scans	1616	$9	$14 011	3%
Tapes	1802	$6	$11 398	3%
Radiography	740	$11	$8346	2%
Surgery	446	$18	$8099	2%
Total	1940	$223	$433 575	100%

CT indicates computed tomography.

from a social perspective and costs included direct medical, direct nonmedical, and indirect costs of both the inpatient and outpatient population.

Model Overview and Design

A cross-sectional prevalence-based cost-of-illness approach was applied. To analyze the full costs, the model included direct medical, direct nonmedical, and indirect costs associated with both ischemic and hemorrhagic stroke. Direct medical costs meant the medical expenditures for procedures and services, such as physician visits, medicines, hospital stays, and diagnostic tests related to stroke. Direct nonmedical costs included travel expenses associated with receiving treatment. Indirect costs measured lost work productivity because of missed days of activity and lost productivity because of premature deaths in the working age groups (15 to 64) or time spent away from the workplace. All costs were converted into US dollars using the 2018 mean exchange rate (1 USD = Rial 100 000).[11]

Context and Population

The number of stroke patients, direct medical costs, and mortality and survival rate were extracted from various resources and registries. We used the hospitals affiliated with the Mashhad University of Medical Sciences health information system registries. Patients included all new cases and old cases of both types of stroke referred or admitted to any of these hospitals in 2018.

Direct Medical Costs

To estimate the direct medical costs, we categorized the whole disease costs into 9 cost categories: lodging, medicines and consumables, doctor visits, laboratory visits, computed tomography scans, tapes, radiography, surgery, and other clinical costs. To estimate the total direct medical costs, we measured the average costs of each category and the number of patients who received treatment in the hospitals affiliated with the Mashhad University of Medical Sciences. The average costs of each category were then multiplied by the number of patients who received treatment in these hospitals in 2018. To estimate the average costs of inpatient care, we reviewed the medical records of patients. To identify and estimate real clinical process items for stroke patients, we used the latest national clinical guideline for stroke. We also checked the latest circular of Iranian medical tariffs related to stroke patients as a means to extract each clinical item's cost. To ensure the accuracy of items and costs, we conducted a short discussion with a vascular neurologist.[12-14]

Direct Nonmedical Costs

Because of the lack of data on nonmedical costs of stroke patient, we only estimated the transportation costs. This cost and the average number of trips made by patients were extracted through interviews with patient family members. Other direct nonmedical costs were not included in the analyses.

Indirect Costs, Patient Time Costs, Mortality Costs, and Disability Costs

To estimate the indirect costs, a human capital approach was used. Moreover, as an assumption, the monetary value of productivity lost because of morbidity and mortality equaled the current wages of patients. We used a prevalence-based approach for 1-year costs; the long-term morbidity costs associated with strokes were not included in the cost analyses.

The average number of days that each patient lost because of receiving care were calculated using the medical record data and

Table 2. The patient time costs for strokes in Iran in 2018 (estimated in US dollars).

Status	Number of patients	Mean of missed work days	Total of missed work days	Mean cost per day	Total cost
Employed patients	570	4.04	2302.8	$10	$23 028
Unemployed patients	1370	4.48	6137.6	$5	$30 688
Accompanies	1940	4.35	8439	$5	$42 195
Total					$95 911

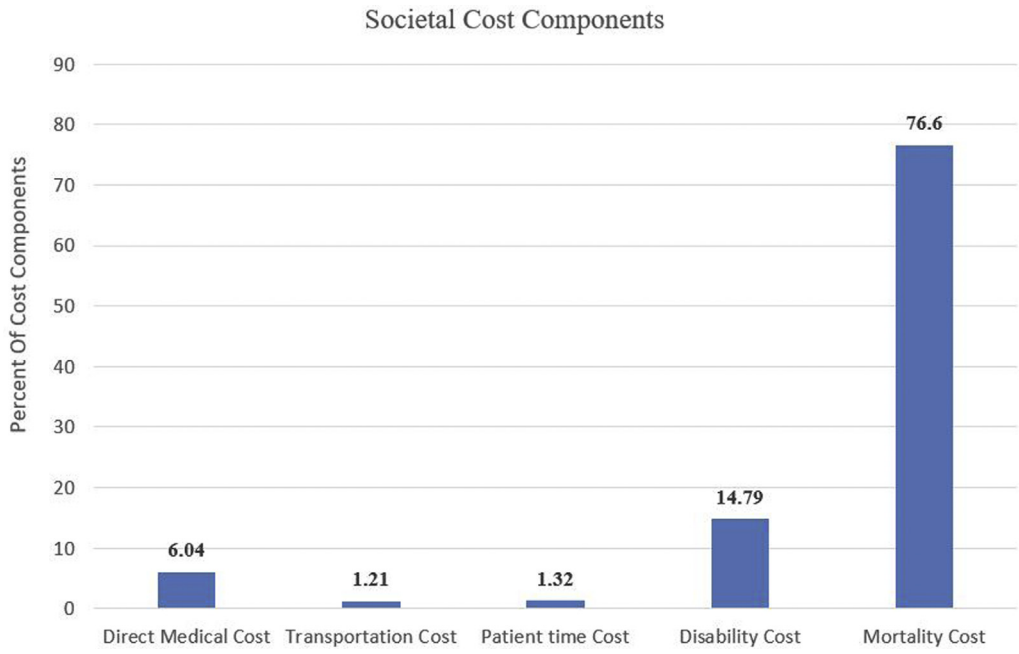
Table 3. The mortality costs for stroke in Iran in 2018 (estimated in US dollars).

Age group (year)	Number of deaths	Mean mortality cost	Total cost
30-39	4	$105 575	$422 300
40-49	2	$61 419	$122 838
50-59	34	$31 230	$1 061 820
60-69	42	$11 562	$485 604
70 ≤	112	$899	$100 688
Total	194	Mortality cost per case: $11 305	$2 193 250

Table 4. The summary of all types of costs in US dollars for strokes in Iran in 2018.

Type of costs	All studied patients costs	Per patient costs	Total costs for country
Direct medical costs	$433 575	$223	$22 300 000
Transportation costs	$87 300	$45	$4 500 000
Patient time costs	$95 911	$49	$4 900 000
Disability costs	$1 271 088	$728	$54 600 000 (for 75 000 survived patients in one year in Iran)
Mortality costs	$2 193 250	$11 305	$282 625 000 (for 25 000 death in on year in Iran)
Total annual costs	$4 081 124	$12 350	$368 925 000

Figure 1. Societal cost components of stroke in Iran, 2018.



also by interviewing the patient's family. The number of deaths, years of potential life lost, and the value of each year were measured to estimate the mortality costs.[15] The potential life-years lost were defined as the remaining years of life at the age of death based on World Bank life expectancy data for Iran.[16,17] To estimate the disability costs, we considered the costs associated with the patient's rehabilitation programs.

Results

The direct medical costs of stroke patients are shown in Table 1. The 1940 cases were admitted or referred to Mashhad University of Medical Science–affiliated hospitals in the study period. About 58% of the patients were men and the mean age for both women and men was about 65 years old. Because all patients had lodging,

medicine, consumables, and visit costs, the expenditure of these components were calculated for all incident cases of stroke.

The greatest part of the direct medical cost (44%) was the cost of lodging. Lodging, medicine, and consumables accounted for 69% of all direct medical costs ($299 959).

In total, patients spent $87 300 on transportation during their treatment. The average number of trips taken by patients and family were 15 trips, based on the 64 people who were interviewed. The mean cost per trip was estimated at approximately $3. The minimum wage rate in Iran for 2018 was assigned to unemployed patients. We estimated that the patient's time cost was about $95 911 for all 1940 included patients (Table 2).

Based on the opinions of a team of rehabilitation specialists (including occupational therapy, physiotherapy, and speech therapy practitioners), a patient who has had a stroke will need at least 2 rehabilitation sessions per week for a year. Moreover, the rehabilitation tariff based on telephonic interviews with 3 rehabilitation clinics was $7 per session. In total, 1746 out of the 1940 patients in this study survived after stroke (90%), amounting to a cost of $1 271 088 in therapy.

In Table 3, we provide the age-specific mortality rate and the costs of mortality resulting from strokes. The number of mortalities in the studied hospitals in 2018 was 194 cases (or 10% of all stroke patients referred to the studied hospitals). Most of the patients who died were in the age group above 70 years (57%), and the total mortality cost was about $2 193 250.

The per case cost of mortality was about $11 305. According to the *Iranian Ministry of Medical Health and Education Reports*, the prevalence of stroke cases in Iran is about 100 000 per year (including 35% new and 65% old cases); of the 100 000 cases, approximately 25 000 lead to death.[18,19] We also presented the summarized costs as per patient's annual costs, as well as total annual societal costs for the country in the year 2018 (Table 4).

Overall, the economic burden of stroke in 2018 for the studied 1940 patients was approximately $4 081 124. The annual cost per patient was $12 350. The total annual societal costs were thus about $368 925 000. The main components of the cost were mortality costs (76.6%) and disability costs (14.7%) (Fig. 1).

Discussion

This study was one of the first attempts to estimate the economic impact of stroke in Iran. The present study on economic burden used a prevalence-based method and human capital approach to estimate the societal annual costs. We showed that the total economic burden of stroke patients in studied hospitals was $4 081 124 for all 1940 patients in 2018 and most of these costs were because of productivity losses resulting from deaths. As a result, one stroke patient imposes $12 350 annually. Bearing in mind the approximately 100 000 strokes in Iran each year, including about 35 000 new cases,[18,19] it is estimated that stroke imposed a cost of $368 925 000 to Iran in 2018. At first glance, these estimated costs may look low compared with similar studies,[20-22] but it is important to consider that Iran is involved in an economic crisis and its currency value has weakened in recent years compared with the US dollar.[23] The mean exchange rate in 2018 was 100 000 Iran Rials per 1 US dollar. Xu et al estimated that the economic impact of stroke in Euros was €1.74 billion for England, Wales, and Northern Ireland for the year 2015.[24] In line with other population-based economic impact studies, lodging, medicine, and consumable costs accounted for the main part of the direct medical costs.[25] Some authors argue that the costs of medical services in Iran are less than in some other Middle Eastern countries and developed countries.[26] For example, in Iran, the public services tariff is much lower than that in the private sector.[27,28] Nevertheless, in the present study, the medical costs accounted for about 6.0% of all societal costs in studied patients. In line with similar studies,[2,29,30] the main cost factor was the mortality cost, which accounted for 76.6% of all societal costs.[22] Most patients who died were in the age group above 70 years (57%); 79% of stroke patients who died were above 60 years, coinciding with other studies, which have noted that 50% of all strokes occur in people over the age of 75 and 30% in people over the age of 85. Ultimately, 14.79% of all societal costs in Iran for stroke care fell on rehabilitation. Meanwhile, it was reported that rehabilitation care consumed 40% of all stroke costs in Sweden in 2012.[21] Similarly, a systematic review on poststroke care costs revealed that rehabilitation services were the main cost driver of poststroke care in almost all of the included studies.[31]

Applying a societal approach for cost analysis and considering the disability costs are the strengths of the present study. Nevertheless, there are some recognized limitations of our study. First, as we mentioned, the medical care tariff in Iran may not show the real costs imposed on the health system. Second, the widely used human capital approach underestimates the value of life for some groups of people.[32] Third, this study was conducted based on hospitalized patient data in public hospitals affiliated with Mashhad University of Medical Science in 2018, which may limit the ability to generalize the results to the other medical centers in the country.

Conclusion

The economic impact of stroke is considerable. The premature deaths and disabilities resulting from strokes accounted for the main productivity losses and all societal costs of stroke. Healthcare providers and decision makers are recommended to expand healthy lifestyle choices in society to control hypertension and decrease the burden of stroke, especially in elderly age groups. Nevertheless, it seems necessary to design a registration system at the national level for stroke patients.

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REFERENCES

1. Feigin VL, Lawes CM, Bennett DA, Anderson CS. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case-fatality in the late 20th century. *Lancet*. 2003;2(1):43–53.
2. Feigin VL, Krishnamurthi RV, Parmar P, et al. Update on the global burden of ischemic and hemorrhagic stroke in 1990-2013: the GBD 2013 study. *Neuroepidemiology*. 2015;45(3):161–176.
3. Katan M, Luft A. Global burden of stroke. *Semin Neurol*. 2018;38(02):208–211.
4. Fantom N, Serajuddin U. *The World Bank's classification of countries by income. Policy Research Working Paper No. 7528*. World Bank; 2016.
5. Salehi M, Amiri A, Thrift AG, et al. Five-year recurrence rate and the predictors following stroke in the Mashhad stroke incidence study: a population-based cohort study of stroke in the Middle East. *Neuroepidemiology*. 2018;50(1-2):18–22.
6. Delbari A, Roghani RS, Tabatabaei SS, Lökk J. A stroke study of an urban area of Iran: risk factors, length of stay, case fatality, and discharge destination. *J Stroke Cerebrovasc Dis*. 2010;19(2):104–109.
7. Kim SG, Hahm MI, Choi KS, Seung NY, Shin HR, Park EC. The economic burden of cancer in Korea in 2002. *Eur J Cancer Care*. 2008;17(2):136–144.
8. Gustavsson A, Svensson M, Jacobi F, et al. Cost of disorders of the brain in Europe 2010. *Eur Neuropsychoparmacol*. 2011;21(10):718–779.
9. Taplin SH, Barlow W, Urban N, et al. Stage, age, comorbidity, and direct costs of colon, prostate, and breast cancer care. *J Natl Cancer Inst*. 1995;87(6):417–426.
10. WHO. WHO guide to identifying the economic consequences of disease and injury. https://www.who.int/choice/publications/d_economic_impact_guide.pdf?ua=1. Accessed January 22, 2020.
11. Zahedi R, Azadi P. *Central banking in Iran. Working Paper 5, Stanford Iran 2040 Project*. Stanford University; 2018.
12. Rudd AG, Bowen A, Young GR, James MA. The latest national clinical guideline for stroke. *Clin Med*. 2017;17(2):154.
13. Habibi-koolaee M, Shahmoradi L, Niakan Kalhori SR, Ghannadan H, Younesi E. Prevalence of stroke risk factors and their distribution based on stroke subtypes in Gorgan: a retrospective hospital-based study–2015-2016. *Neurol Res Int*. 2018, 2709654.
14. Moradi-Lakeh M, Vosoogh-Moghaddam A. Health sector evolution plan in Iran; equity and sustainability concerns. *Int J Health Policy Manag*. 2015;4(10):637–640.
15. Max W, Sung H-Y, Stark B. The economic burden of breast cancer in California. *Breast Cancer Res Treat*. 2009;116(1):201–207.
16. Delavari S, Zandian H, Rezaei S, et al. Life expectancy and its socioeconomic determinants in Iran. *Electron Physician*. 2016;8(10):3062–3068.
17. Shahraki M. Public and private health expenditure and life expectancy in Iran. *Payesh*. 2019;18(3):221–230.
18. Daneshfard B, Izadi S, Shariat A, Toudaji MA, Beyzavi Z, Niknam L. Epidemiology of stroke in Shiraz, Iran. *Iran J Neurol*. 2015;14(3):158–163.
19. Hosseini AA, Sobhani-Rad D, Ghandehari K, Benamer HT. Frequency and clinical patterns of stroke in Iran-systematic and critical review. *BMC Neurol*. 2010;10(1):72.
20. Youman P, Wilson K, Harraf F, Kalra L. The economic burden of stroke in the United Kingdom. *Pharmacoeconomics*. 2003;21(1):43–50.
21. Persson J, Ferraz-Nunes J, Karlberg I. Economic burden of stroke in a large county in Sweden. *BMC Health Serv Res*. 2012;12(1):341.
22. Kim H-J, Kim Y, Seo H-Y, Kim E-J, Yoon S-J, Oh I-H. The economic burden of stroke in 2010 in Korea. *J Korean Med Assoc*. 2012;55(12):1226–1236.
23. Arab-zozani M, Barghazan SH. Health sector evolution in Iran: a short review. *EBHPME*. 2017;1(3):193–197.
24. Xu X-M, Vestesson E, Paley L, et al. The economic burden of stroke care in England, Wales and Northern Ireland: using a national stroke register to estimate and report patient-level health economic outcomes in stroke. *Eur Stroke J*. 2018;3(1):82–91.
25. Wang G, Zhang Z, Ayala C, Dunet DO, Fang J, George MG. Costs of hospitalization for stroke patients aged 18-64 years in the United States. *J Stroke Cerebrovasc Dis*. 2014;23(5):861–868.
26. Kazemi Z. Study of the effective factors for attracting medical tourism in Iran. *Student Thesis*. 2008.
27. Doshmangir L, Rashidian A. Unresolved issues in medical tariffs: Challenges and respective solutions to improve tariff system in Iranian health sectors. *J Hospital*. 2012;10(4):21–30.
28. Rezaei S, Sari AA, Woldemichael A, Soofi M, Kazemi A, Matin B. Estimating the economic burden of lung cancer in Iran. *Asian Pac J Cancer Prev*. 2016;17(10):4729.
29. Cha Y-J. The economic burden of stroke based on South Korea's national health insurance claims database. *Int J Health Policy Manag*. 2018;7(10):904–909.
30. Joo H, Wang G, Yee SL, Zhang P, Sleet D. Economic burden of informal caregiving associated with history of stroke and falls among older adults in the US. *Am J Prevent Med*. 2017;53(6):S197–S204.
31. Rajsic S, Gothe H, Borba H, et al. Economic burden of stroke: a systematic review on post-stroke care. *Eur J Health Econ*. 2019;20(1):107–134.
32. Brown ML, Yabroff K. Economic impact of cancer in the United States. In: Schottenfeld D, Fraumeni JF, eds. *Cancer Epidemiology and Prevention*. Oxford, UK: Oxford University Press; 2006:202.